

An important aspect of Applicant's invention is that on each end an element is provided that is a manifold which has either an inlet and two branches on an outlet and two inlet branches. This is a particular element or piece with a single channel branching to two channels where the two channels or branches are bent relative to the single channel to provide a predetermined angle or direction relative to the single channel. The invention then provides a single bend direction arch tube for a connection to each of the branches of the manifold. This has extensive advantages as detailed below.

The Cage et al. reference provides a basic V-shaped tube arrangement wherein single bends are provided to form a first straight portion and two side straight portions of the tube for a simple connection to a manifold structure. There are no curved branches as there is a simple straight connection to a manifold inlet or outlet. As such the Cage et al. reference directs the person of ordinary skill in the art toward a simple and relatively standard or typical design. The actual development or advancement of the Cage et al. Patent (Cage et al. '898) is the provision of a high temperature coriolis mass flow rate meter. This aspect of the development, namely a meter that is suited for operation at relatively high temperatures, is not related directly to the technique of oscillating the tubes and detecting the oscillation. As such, the development of Cage et al. is not related to the size or shape of the tubes and the connection thereof. For this reason Cage et al. notes that the development of the Cage et al. reference uses a particular U-shape flow conduit structure but other sizes and shapes of conduits can be used while still practicing the concepts which relate to the provision of a meter that is suited for operation at relatively high temperatures. Accordingly, the statement as to potential variations in the size

and shape is not a teaching or suggestion of providing a particular size or shape in an arrangement as claimed but instead merely points out to the person of ordinary skill in the art that the principals relating to the provision of a meter that is suited for high temperatures may be provided by an arrangement other than the U-shape form disclosed. Accordingly this is really no direction or motivation for the person of ordinary skill in the art. Instead this simply notes that in providing a high temperature meter as proposed by Cage et al., the U-shape form is not a strict requirement. This is quite different from a teaching or suggestion to provide a combination of features as claimed.

The Lew et al. reference essentially discloses a complicated tube form wherein tube parts 46 and 47 are joined in an un-shown way with tubes parts 44 and 45. However, tube parts 46 and 47 have no branches and identical tubes 44 and 45 have two sets of curves and are not arched curving continuously in one direction (claim 5) or arched with a curve in one direction as per claims 1 and 12. Accordingly, even considering Lew et al. with Cage et al., there is still a lack of teaching of a manifold element with branches which are curved and with arch tubes curved in only one direction which are joined to respective branches.

The Keita reference is said to show curved branches of a manifold. However, Keita discloses only the curve of an arched tube joined to angled openings in an end plate of a manifold. Accordingly, Keita does not disclose as per claim 1 or claim 12 the manifold with curved branches, namely individual branch elements and does not disclose as per claim 5 manifolds with outlet ports with branches which are bent relative to the inlet port portion. The similar language is present in claim 12 where the Keita et al. reference fails to teach and fails

to suggest these features.

Keita et al. fairly teaches three basic constructions. Only one of the constructions uses a pair of arch tubes curved in one direction only. In this case the manifold is a single chamber with two openings in an end face with the arch tubes joined through these openings (see Figs. 1, 2a and 3). In the other embodiments of Keita et al. the tubes have multiple bends. No reference presents the suggestion or teaching as per the invention of having an arched tube with a single direction of bend and a manifold having plural branches each bent to join to the direction of the arch tube. Absent such a teaching, the combination of features including these features as well as parallel tubes and other aspects claimed should not be considered obvious. The prior art is lacking a teaching reference of providing the combination of features as claimed. The provision of identical tubes bent at two locations as per Lew et al. with a welding or other joining to single chamber or conduit end pieces 47 and 46 does not present the necessary teaching. Cage et al. also fails to present any direction and teaching of providing the combination of features claimed.

Applicant has noted that the invention presents significant advantages as compared to the prior art.

It is known in the prior art that coriolis mass flow meters may be provided in various different forms.

A straight flow tube type meter has straight flow tubes disposed in the direction of the external conduit. The straight tube are oscillated in the middle part and a coriolis force caused on the straight tubes is detected. Because the flow tubes are straight it is natural for the

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manifolds to be connected to the flow tube so as to come into a line or be in line.

U-shaped flow tube type meters have been extensively used and are provided such as in Cage et al. '898 or Cage '385 or Cage '031. In this formation the side legs are straight. The side legs of the tubes are oscillated and the coriolis force applied by the gas in the tubes is detected. In such a case side legs perpendicular to the bending axis are utilized for generating the coriolis forces.

Because the side legs themselves are straight just as in the straight flow tubes of the straight flow type meter, it is natural that the manifolds are connected to the side legs of the tubes so as to be in line. This is by a simple opening in the top of the manifold (see Cage et al. '898) or by an extension of the manifold with openings as per Cage '385 or a similar construction.

The general teachings of the prior art are such that there is no suggestion that straight side legs should be deformed. Because of this the manifolds may be relatively simple with a simple connection to the straight side legs.

Cage et al. '898 discloses such usual U-shape flow tubes which have usual straight side legs and a straight forward manifold connection based on the connection to the straight side legs.

Flow tubes of an arch shape have a curve which is, arc shaped. The present invention provides such an arc shape or an arch tube. As such they do not have side legs, particularly there are no straight side legs. The whole section of the flow tube is therefore utilized for generating coriolis forces. This is quite different from the prior art.

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An arch shape type coriolis mass flow meter utilizes similar principles as a straight tube flow meter. However, the arch shape type flow meter generates coriolis forces by utilizing partially the same principals as a U-shape type coriolis mass flow meter. As such the type should be discriminated with respect to each other in that both their function and construction are quite different.

As noted above, the mention in Cage et al. of changing the shape relates to the fact that the features of the high temperature flow meter disclosed are not limited to a U-shape. However, this does not present any teaching or suggestion of providing the combination of features as claimed. The prior art as a whole fails to teach each feature as specified in the claims. As such, there is no suggestion to provide the combination of the invention.

Applicant respectfully requests that the Examiner discuss the subject matter of this application with Applicant's representative at a time soon after receipt of this Amendment. Applicant's representative has tried on several occasions to contact the Examiner but the message has not been replied to. It is hoped that Applicant can have the opportunity to discuss the various teachings with regard to the subject matter claimed. It is also hoped that the claim language can be discussed in an attempt to reduce as many outstanding issues as possible.

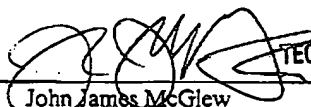
Favorable consideration is requested.

Respectfully submitted
for Applicant,

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JAN 21 2003

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Enclosed: Marked-Up Version of the Claims

DATED: January 21, 2003
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SHOULD ANY OTHER FEE BE REQUIRED, THE PATENT AND TRADEMARK OFFICE
IS HEREBY REQUESTED TO CHARGE SUCH FEE TO OUR DEPOSIT ACCOUNT 13-
0410.

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MARKED-UP VERSION OF THE CLAIMS

1. (~~Twice~~Three Times Amended) A Coriolis mass flow meter, comprising:
two parallel flow tubes curved into an arch shape having joint ends, each of the joint
ends having an end direction;

an entry-side manifold that ~~is~~with curved branches connected to one set of said joint
ends of said two flow tubes ~~and, said branches each carrying a portion of a fluid being measured~~
from an inlet port into said two flow tubes;

an exit-side manifold that ~~is~~with curved branches connected to another set of said joint
ends of said two flow tubes ~~and converges, said exit-side manifold with curved branches~~
converging flows of said fluid being measured flowing in said two flow tubes into an outlet port
to discharge said fluid being measured;

a drive unit for driving and resonating one of said flow tubes with another of said flow
tubes at mutually opposite phases; and

a pair of oscillation sensors installed along said two parallel flow tubes curved into an
arch shape at locations horizontally symmetrical with respect to an installation location of said
drive unit for sensing a phase difference proportional to a Coriolis force, said two flow tubes
being connected to said entry-side manifold and to said exit-side manifold at respective said
joint ends and said two flow tubes being formed into the arch shape that is bent in only one
direction, said entry-side manifold ~~having two manifold outlets~~curved branches being smoothly
bent; from an inlet direction of said entry-side manifold to a connection to direction at an end
of said flow tubes at said joint ends, at a predetermined rise angletwo manifold outlets that is
the same as the angle end direction of the said joint ends, said exit-side manifold ~~having two~~
~~manifold inlets~~curved branches being smoothly bent; from an outlet direction of said exit-side
manifold to a connection to direction at an end of said flow tubes at said joint ends, at a
predetermined rise angletwo manifold inlets that is the same as the angle end direction of the
said joint ends.

5. (AMENDED) A Coriolis mass flow meter comprising:

two flow tubes each having a curve and each flow tube having first and second joint
ends, each curve of said flow tubes lying in a respective plane, said planes of said curves of said
flow tubes being arranged substantially parallel, said each curve being in only one direction and
forming an arch extending fully from a respective said first joint end to a respective
second joint end;

an entry-side manifold with an inlet port portion and two outlet ports forming branches
curved with respect to the inlet port portion, said two outlet ports port branches being
connected to said first joint ends of said two flow tubes and dividing an entry passage from said
inlet port into said branches joined to said two flow tubes, said entry passages having a smooth
curve from said inlet port to said outlet ports with an axial direction of each of said outlet ports
at an acute angle relative to said an axial direction of said inlet port, an axial direction of said

entry passage at said outlet ports being in a substantially same direction as an axial direction of a respective said flow tube at said respective first joint end of said respective flow tube;

15 an exit-side manifold with an outlet port portion and two inlet portsport branches, said inlet portsport branches being connected to said second joint ends of said two flow tubes and joining exit passages from said inlet ports to said outlet port portion, each of said exit passages having a smooth curve from respective said inlet ports to said outlet port with an axial direction of each of said inlet ports at an acute angle relative to an axial direction of said outlet port portion, an axial direction of said exit passages at said inlet ports being in a substantially same direction as an axial direction of a respective said flow tube at said respective second joint end of said respective flow tube;

20 a drive unit for driving and resonating one of said flow tubes with respect to another of said flow tubes at mutually opposite phases;

25 a pair of oscillation sensors installed at locations symmetrical with respect to said drive unit for sensing a phase difference proportional to a Coriolis force of fluid in said two flow tubes.